Meckel Diverticulum

The Mayo Clinic Experience With 1476 Patients (1950–2002)

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Objective: Through a comprehensive review of the Mayo Clinic experience with patients who had Meckel diverticulum, we sought to determine which diverticula should be removed when discovered incidentally during abdominal surgery.

Summary Background Data: Meckel diverticula occur so infrequently that most articles have reported either small series or isolated cases. From these limited series, various conclusions have been reported without clearly indicating which incidental diverticula should be removed.

Methods: Medical records were reviewed of 1476 patients found to have a Meckel diverticulum during surgery from 1950 to 2002. Preoperative diagnosis; age; sex; date of surgery; and intraoperative, macroscopic, and microscopic findings from operative and pathology reports were recorded. Logistic regression analysis was used to determine which clinical or histologic features were associated with symptomatic Meckel diverticulum. The features analyzed were age; sex; length, base width, and ratio of length to base width of the diverticulum; and the presence of ectopic tissue or abnormal tissue (inflammation or enteroliths).

Results: Among the 1476 patients, 16% of the Meckel diverticula were symptomatic. The most common clinical presentation in adults was bleeding; in children, obstruction. Among patients with a symptomatic Meckel diverticulum, the male-female ratio was approximately 3:1. Clinical or histologic features most commonly associated with symptomatic Meckel diverticula were patient age younger than 50 years (odds ratio [OR], 3.5; 95% confidence interval [CI], 2.6–4.8; $P < 0.001$), male sex (OR, 1.8; 95% CI, 1.3–2.4; $P < 0.001$); diverticulum length greater than 2 cm (OR, 2.2; 95% CI, 1.1–4.4; $P = 0.02$), and the presence of histologically abnormal tissue (OR, 13.9; 95% CI, 9.9–19.6; $P < 0.001$).

Conclusions: After analyzing our data, we neither support nor reject the recommendation that all Meckel diverticula found incidentally should be removed, although the procedure today has little risk. If a selective approach is taken, we recommend removing all incidental Meckel diverticula that have any of the 4 features most commonly associated with symptomatic Meckel diverticulum.

(*Ann Surg* 2005;241: 529–533)

Meckel diverticulum is a congenital, intestinal blind pouch that results from an incomplete obliteration of the vitelline duct during the fifth week of gestation. Wilhelm Fabricius Hildanus, a German surgeon, first described the diverticulum in 1598.[1,2] However, the entity was not named until 1809, when Johann Friedrich Meckel the Younger first reported his research on the diverticulum's anatomy and embryology.[3,4] Furthermore, Meckel showed that incomplete obliteration of the vitelline duct results in not only Meckel diverticulum but also enterocysts, intestinal-umbilical fistulas, and mesodiverticular bands.

During the past 10 years, more than 1600 articles have been published on Meckel diverticulum (according to a PubMed search for "Meckel Diverticulum" from 1992–2002). Because of the rare incidence of Meckel diverticulum, most publications have been either small series or case reports. Various conclusions (such as the age-sex distribution, most common clinical presentation, and percentage of ectopic tissue in a symptomatic Meckel diverticulum) have been reported from these limited series.[5–10]

Our objective was to report the Mayo Clinic experience with Meckel diverticulum and determine which diverticula should be removed if discovered as an incidental finding.

MATERIALS AND METHODS

Through a review of medical records, 1476 patients were identified who were found to have a Meckel diverticulum during surgery from 1950 to 2002. Preoperative diagnosis, age, sex, and date of surgery were recorded. Intraoperative, macroscopic, and microscopic findings were also retrieved from operative and pathology reports. Findings included the presence of perforation, the length and base width of the diverticulum, and the presence of ectopic tissue, inflammation, and enteroliths within the diverticulum.

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ISSN: 0003-4932/05/24103-0529

DOI: 10.1097/01.sla.0000154270.14308.5f

An asymptomatic Meckel diverticulum was defined as one that was found incidentally during an operation and that was not associated with the preoperative diagnosis. A symptomatic Meckel diverticulum was defined as one that the surgeon believed was the main contributing factor to the preoperative diagnosis.

A pediatric patient was defined as a patient younger than 11 years. An adult patient was defined as a patient 11 years or older.

The most recent 100 diverticulectomies were reviewed for postoperative complications and mortality. The location of any ectopic tissue was identified through the operative and pathology reports.

The Mayo Foundation institutional review board approved this retrospective study. Funding was provided by the Mayo Foundation.

RESULTS

Of the 1476 Meckel diverticula that were found during an operation, 1238 (84%) were asymptomatic and 238 (16%) were symptomatic; 844 of the 1238 asymptomatic diverticula (68%) were resected, and all 238 of the symptomatic diverticula were resected. The reason for removing an asymptomatic Meckel diverticulum was based on the surgeon's preference.

Age Distribution

The mean age (± SD) of patients with a symptomatic Meckel diverticulum was 31 ± 23.6 years (median, 27 years). Among the 238 patients with a symptomatic Meckel diverticulum, 180 (76%) were adult patients, and 58 (24%) were pediatric patients. The frequency of symptomatic Meckel diverticulum decreased with age in the pediatric population (Fig. 1) and in the adult population (Fig. 2). The age of the oldest patient who required an operation for symptomatic Meckel diverticulum was 91 years.

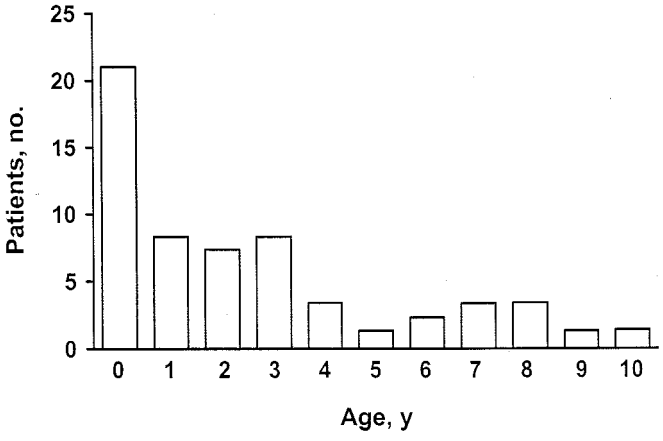

FIGURE 1. Frequency of symptomatic Meckel diverticulum by age in the pediatric population.

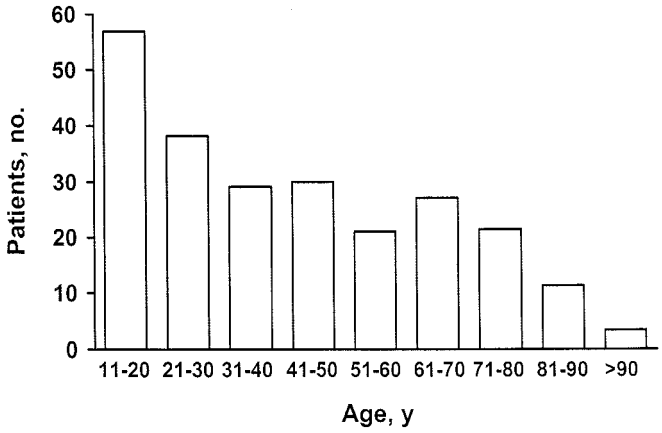

FIGURE 2. Frequency of symptomatic Meckel diverticulum by age in the adult population.

Sex Distribution

The male-female ratio for symptomatic Meckel diverticulum was approximately 3:1 in the adult population (72% versus 28%) and in the pediatric population (72% versus 28%). The ratio for asymptomatic Meckel diverticulum was also approximately 3:1 in the pediatric population (73% versus 27%), but it was smaller in the adult population (58% versus 42%).

Clinical Presentation

Among adult patients, the most common presentations of symptomatic Meckel diverticula (n = 180) were bleeding, obstruction, and diverticulitis. Bleeding was present in 69 patients (38%), including 1 who bled from a leiomyosarcoma. Obstruction was present in 61 patients (34%), including 10 who presented with volvulus, 9 who presented with intussusception, 2 who presented with invasive carcinoid tumor, and 2 who presented with incarcerated hernia. Diverticulitis was present in 50 patients (28%), including 18 who presented with perforated diverticulitis and 2 who presented with diverticulitis from a foreign body (fish bone).

Among pediatric patients, the most common presentations of symptomatic Meckel diverticula (n = 58) were obstruction (23 patients; 40%), including 8 patients who presented with intussusception and 4 who presented with volvulus; bleeding (18 patients; 31%); and diverticulitis (17 patients; 29%), including 7 patients who presented with perforated diverticulitis.

Histopathologic Findings in Symptomatic Meckel Diverticulum

Among the 180 resected diverticula in symptomatic adults, 74% were histologically abnormal: 43% contained

ectopic tissue, 6% had enteroliths within the lumen, and 25% had evidence of diverticulitis. The most common ectopic tissues were gastric (33%), pancreatic (5%), and carcinoid (2%) (Table 1); 63% of bleeding diverticula in the adults contained ectopic gastric mucosa.

Among the 58 resected diverticula in symptomatic pediatric patients, 59% contained ectopic tissue and 41% were histologically normal. The most common ectopic tissues were gastric (30 patients; 52%), pancreatic (3 patients; 5%), and colonic (1 patient; 2%); 78% of bleeding diverticula in the pediatric patients contained ectopic gastric mucosa.

Histopathologic Findings in Asymptomatic Meckel Diverticulum

Of the 844 resected, asymptomatic diverticula, 806 (96%) were in adults. Among the resected diverticula in these adults, 18% were histologically abnormal: 14% contained ectopic tissue and 4% had evidence of diverticulitis with or without enteroliths present. The most common ectopic tissues were gastric (8%), pancreatic (3%), and carcinoid (2%) (Table 2).

Of the 844 resected, asymptomatic diverticula, 38 (4%) were in pediatric patients. Among the resected diverticula in these pediatric patients, 16% were histologically abnormal: 11% contained ectopic tissue and 5% had evidence of diverticulitis. The only ectopic tissues found were gastric (3 patients; 8%) and pancreatic (1 patient; 3%).

Characteristics of Symptomatic Meckel Diverticulum

Logistic regression analysis was used to determine which clinical or histologic features were associated with symptomatic Meckel diverticulum. Analyzed features were age; sex; length, base width, and ratio of length to base width of the diverticulum; and the presence of ectopic tissue or abnormal tissue (inflammation or enteroliths). The following associations were statistically significant: patient age younger than 50 years (odds ratio [OR], 3.5; 95% confidence interval [CI], 2.6–4.8; $P < 0.001$), male sex (OR, 1.8; 95% CI, 1.3–2.4; $P < 0.001$), diverticulum length greater than 2 cm (OR, 2.2; 95% CI, 1.1–4.4; $P = 0.02$), and the presence of histologically abnormal tissue (OR, 13.9; 95% CI, 9.9–19.6; $P < 0.001$). The width and ratio of length to base width of a diverticulum were not associated with symptomatic diverticula.

TABLE 1. Histopathologic Findings in 180 Resected, Symptomatic Meckel Diverticula From Adult Patients

	Patients	
Finding	**No.**	**%**
Ectopic tissue		
Gastric	59	32.8
Pancreatic	9	5.0
Carcinoid	4	2.2
Duodenal	3	1.7
Lipoma	2	1.1
Leiomyosarcoma	1	0.6
Diverticulitis	45	25.0
Enterolith	11	6.1
No abnormality	46	25.6

TABLE 2. Histopathologic Findings in 806 Resected, Asymptomatic Meckel Diverticula From Adult Patients

	Patients	
Finding	**No.**	**%**
Ectopic tissue		
Gastric	67	8.3
Pancreatic	22	2.7
Carcinoid	17	2.1
Duodenal	5	0.6
Lipoma	2	0.2
Mucocele	1	0.1
Leiomyoma	1	0.1
Metastatic adenocarcinoma	1	0.1
Diverticulitis	26	3.2
Enterolith	6	0.7
No abnormality	658	81.6

Morbidity and Mortality

The 100 most recently resected Meckel diverticula were reviewed for postoperative complications: 31 were symptomatic and 69 were found incidentally at the time of the operation. In the symptomatic group, 4 (13%) postoperative complications and no deaths occurred (Table 3). In the asymptomatic group, 14 (20%) postoperative complications, including 1 death (1%), occurred (Table 4). None of the complications in either group or the death in the asymptomatic group was attributable to resection of the Meckel diverticulum.

Location of Ectopic Tissue

The 100 most recently resected diverticula were reviewed for ectopic tissue location: microscopically identified ectopic tissue was found in 21 diverticula, and a palpable mass was identified during resection in only 8 of the 21 specimens (38%). Therefore, 62% of the ectopic tissue specimens from our sample were nonpalpable at the time of surgery. In addition, 13% of the palpable ectopic tissue specimens were found at the base of the Meckel diverticulum.

TABLE 3. Postoperative Complications From Diverticulectomy in 4 Patients With Symptomatic Meckel Diverticulum

Diagnosis*	Age, y	Complication	Time After Diverticulectomy
Obstruction	37	Partial small bowel obstruction	4 mo
Obstruction	30	Partial small bowel obstruction	12 mo
Obstruction	42	Partial small bowel obstruction	2 wk
Bleeding	68	*Clostridium difficile* colitis	

*Obstruction caused by Meckel diverticulum or bleeding from Meckel diverticulum.

DISCUSSION

The incidence of Meckel diverticulum in the general population is 1%.[3,11] From our data, we know that 16% of all patients with Meckel diverticulum were symptomatic and that 29% of all Meckel diverticula contained ectopic or abnormal tissue. We also know that the most common presentation in a child was obstruction, and in an adult, bleeding. Traditionally, pediatric patients have been considered to be patients younger than 18 years. In our series, we defined pediatric patients as patients younger than 11 years. In our analysis of symptomatic Meckel diverticulum, we found that clinical presentation differed between older and younger patients. Younger patients (especially those younger than 4 years) tended to present with obstruction, whereas older patients tended to present with bleeding. Had we used the traditional pediatric age of younger than 18 years, this distinction would have been lost, with most patients in both groups presenting with bleeding. Furthermore, we observed a general 3-to-1 rule: 75% of symptomatic patients were older than 10 years, 75% of symptomatic patients were males, and about 75% of bleeding diverticula contained ectopic gastric tissue.

We do not know, however, whether all incidental Meckel diverticula found during laparotomy should be resected. Cullen et al,[12] after completing an epidemiologic, population-based study, recommended resection in patients younger than 80 years. In our study, which was not an epidemiologic, population-based study, we attempted to answer the question from a different approach and looked at the association between certain characteristics and how often they occurred in symptomatic diverticula. We found that (1) patient age younger than 50 years; (2) male sex; (3) diverticulum length greater than 2 cm; and (4) ectopic or abnormal features within a diverticulum were all associated with symptomatic diverticula and that the width and length-width ratio were not. Although we do not disagree with the conclusions of Cullen et al,[12] we want to emphasize that we recommend removing all incidental diverticula that fulfill any of these 4 criteria. Our own data showed that when 1 criterion was met, the overall proportion of symptomatic Meckel diverticulum was 17%. When 2, 3, or all 4 criteria were met, the proportion increased to 25%, 42%, and 70%, respectively.

In a separate and smaller study, we evaluated the morbidity and mortality from resecting a Meckel diverticulum. Surprisingly, morbidity (20%) and mortality (3%) in the asymptomatic group were higher than morbidity (13%) and mortality (0%) in the symptomatic group. However, in the asymptomatic group, we could not directly correlate any of

TABLE 4. Postoperative Complications From Diverticulectomy in 14 Patients With Asymptomatic Meckel Diverticulum

Diagnosis	Age, y	Complication	Time After Diverticulectomy
Prostate carcinoma	65	Wound infection	
Prostate carcinoma	55	Wound infection	
Diverticulosis	46	Wound infection	
Rectal carcinoma	50	Sexual dysfunction	
Ovarian carcinoma	16	Partial small bowel obstruction	2 mo
Prostate carcinoma	73	Partial small bowel obstruction	5 d
Colon carcinoma	39	Partial small bowel obstruction	3 mo
Ulcerative colitis	28	Partial small bowel obstruction	1 mo
Rectal carcinoma	90	Myocardial infarction (death)	
Bladder carcinoma	79	Myocardial infarction	
Familial adenomatous polyposis	49	Bleeding	3 wk
Bowel obstruction	67	Intra-abdominal abscess	
Bladder carcinoma	72	Incisional hernia	
Bladder carcinoma	70	Respiratory failure	

the complications with the diverticulectomy itself. Therefore, it is still our opinion that the rate of complications from a diverticulectomy is low, which is consistent with findings in the literature.[13–15]

An unresolved question is whether a simple diverticulectomy is sufficient for removing a Meckel diverticulum. From our data, we know that ectopic tissue increases the likelihood that a diverticulum will become symptomatic. We also know that in 13% of the patients with palpable ectopic tissue, the tissue is at the base of the Meckel diverticulum and that in 62% of patients with ectopic tissue, the tissue is not palpable. Therefore, we do not know whether a simple diverticulectomy is sufficient. Because our study did not evaluate the postoperative complications from a Meckel diverticulum removed with a small-bowel resection or with a simple diverticulectomy, we do not know whether the complication rates differ between the methods. Also, we do not know whether ectopic tissue left behind after a simple diverticulectomy becomes symptomatic. At present, our only recommendation is that if a palpable mass is identified at the base of a Meckel diverticulum, the resection margin must be free of the entire mass. For all other Meckel diverticula without a palpable mass, a simple diverticulectomy should be sufficient.

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